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GROUP REPORT

Multi-access Edge Computing (MEC); Study on MEC Application Slices

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Foreword

This Group Report (GR) has been produced by ETSI Industry Specification Group (ISG) Multi-access Edge Computing (MEC).

Modal verbs terminology

In the present document "**should**", "**should not**", "**may**", "**need not**", "**will**", "**will not**", "**can**" and "**cannot**" are to be interpreted as described in clause 3.2 of the ETSI Drafting Rules (Verbal forms for the expression of provisions).

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1 Scope

The present document studies the potential requirements and enhancements to the MEC system needed to support MEC Application Slices. The present document also studies the necessary changes to align the MEC support for network slicing studied in ETSI GR MEC 024 [i.9].The content will include the concept of MEC Application Slices, relationship and alignment with MEC system support for network slicing, as well as potential requirements and enhancements to the MEC system architecture and functions.

2 References

2.1 Normative references

Normative references are not applicable in the present document.

2.2 Informative references

References are either specific (identified by date of publication and/or edition number or version number) or non-specific. For specific references, only the cited version applies. For non-specific references, the latest version of the referenced document (including any amendments) applies.

NOTE: While any hyperlinks included in this clause were valid at the time of publication, ETSI cannot guarantee their long term validity.

The following referenced documents are not necessary for the application of the present document but they assist the user with regard to a particular subject area.

[i.1] ETSI GR MEC 001: "Multi-access Edge Computing (MEC); Terminology".

[i.2] GSMA NG.116: "Generic Network Slice Template Version 8.0", 27 January 2023.

[i.3] ETSI GR MEC 038: "Multi-access Edge Computing (MEC); MEC in Park enterprises deployment scenario".

[i.4] ETSI TS 128 530: "5G; Management and orchestration; Concepts, use cases and requirements (3GPP TS 28.530 Release 18)".

[i.5] 3GPP TR 28.801: "Telecommunication management; Study on management and orchestration of network slicing for next generation network".

[i.6] ETSI GS MEC 010-2: "Multi-access Edge Computing (MEC); MEC Management; Part 2: Application lifecycle, rules and requirements management".

[i.7] ETSI GS MEC 003: "Multi-access Edge Computing (MEC); Framework and Reference Architecture".

[i.8] ETSI TS 123 501: "5G; System architecture for the 5G System (5GS) (3GPP TS 23.501 Release 17)".

[i.9] ETSI GR MEC 024: "Multi-access Edge Computing (MEC); Support for network slicing".

3 Definition of terms, symbols and abbreviations

3.1 Terms

For the purposes of the present document, the terms given in ETSI GR MEC 001 [i.1] and the following apply:

MEC Application Slice: logical MEC application service environment, which provides specific MEC application functions and related MEC service characteristics

MEC Application Slice instance: set of MEC Application instances, MEC service instances, as well as the required resources (e.g. compute, storage and networking resources) which form a deployed MEC Application Slice

MEC Application Slice instance ID: identifier of the MEC Application Slice instance

3.2 Symbols

Void.

3.3 Abbreviations

For the purposes of the present document, the abbreviations given in ETSI GR MEC 001 [i.1] and the following apply:

CSMF	Communication Service Management Function
MAS	MEC Application Slice
MASI	MEC Application Slice Instance
MAST	MEC Application Slice Template
MAS-CSMF	MEC Application Slice Communication Service Management Function
MAS-MF	MEC Application Slice Management Function

4 Overview

The present document studies the potential requirements and enhancements to the MEC system needed to support MEC Application Slices.

Clause 5 documents use cases that illustrate MEC Application Slices in MEC systems to make the concept of "MEC Application Slice" clearer.

Clause 6 proposes all identified key issues and their related solution proposals and evaluation.

Based on identified gaps, clause 7 contains recommendations for further work.

5 Use cases

5.1 Use case #1: Different services need different MEC Application Slices

5.1.1 Description

As stated in GSMA NG.116 [i.2], Network Slices are described by attributes, that is, services with similar attributes will use the same network slices. MEC Application Slices are also similar. Services with similar attributes use the same MEC Application Slices. Judging from the applications that have been deployed or are about to be deployed, MEC carries a variety of industry applications, which can be preliminarily divided into three categories: 2C, 2B and 2H, as shown in Figure 5.1.1-1.

Figure 5.1.1-1: Various Services deployed on MEC

Each category also gives typical services, not all are listed. Here, the 2C scenario is positioned to experience upgrading, which leads to Consumption upgrading services, such as ultra-high speed video, immersive VR and mobile office. 2B scenario aims to provide industry solutions for remote healthcare, smart tourism, smart factory and V2X. 2H is intelligent home service. All the above services have different service attributes.

MEC Application slices are also distinguished according to service attributes, as well as done for Network Slice. The typical service attributes are service bit rate, communication service availability, end-to-end latency and jitter, etc. Different services/attributes need different MEC Application Slices to support.

5.1.2 Recommendations

[Recommendation 5.1.2-1]

- MEC system should be able to distinguish different service attributes.

[Recommendation 5.1.2-2]

- MEC system should be able to allocate the matched MEC Application Slices according to the service attributes.

5.1.3 Evaluation

The list of evaluations that corresponds with the recommendations is as follows:

[Evaluation for Recommendation 5.1.2-1]

- A support for translating the service-related requirement to MEC Application Slices is not specified in the current ETSI MEC specifications.

[Evaluation for Recommendation 5.1.2-2]

- A support for application slice management functions (similar to the ones for network slicing in a 5G network) is not specified in the current ETSI MEC specifications.

5.2 Use case #2: Different enterprises need different MEC Application Slices

5.2.1 Description

5G network forms different network slices by dividing the actual network resources, and different slices are identified by different attributes. Slice, a natural product customized on demand and logically isolated from each other, is favoured by the vertical industry.

Similarly, MEC system should be able to allocate different MEC Application Slices to different enterprises on demand, even though these enterprises operate the same business.

EXAMPLE: In the same industrial park served by MEC system, there are three enterprises operating immersive VR. These immersive VR applications belong to Enterprise A, Enterprise B and Enterprise C, they still need three different MEC Application Slices. Or if there are three enterprises operating smart factories, the MEC system still needs to allocate three different MEC Application Slices respectively. Figure 5.2.1-1 illustrates an example where different MEC Application Slices are allocated to different Enterprises operating the same service.

Figure 5.2.1-1: Different MECAppSlices allocated to different Enterprises operating the same service

5.2.2 Recommendations

- MEC system should be able to allocate the matched MEC Application Slices to Enterprises on demand.

NOTE: This recommendation does not require the MEC system to distinguish different MEC Enterprises.

5.2.3 Evaluation

Recommendations of clause 5.2.2 are technically feasible with the following condition:

- There is a relationship or mapping table between the MEC Application Slices and the Enterprises, which may be on the OSS or higher level and is out the scope of ETSI MEC. The support for the MEC system to instantiate the corresponding MEC Application Slices according to this requirement is still missing.

5.3 Use case #3: Multiple slices are required for diversified services of the same enterprise

5.3.1 Description

There are many scenarios where application slicing can be used. One example is that services with the same/similar attributes can form an application slice. In another example, multiple isolated application slices are needed for enterprises with strongly differentiated security requirements.

If an enterprise operates businesses with large differences in service attributes, then the enterprise needs multiple slices, such as a power grid company. It would need to use three different network slices of the 5G network simultaneously. Distribution automation service has very high requirements on reliability and delay, so distribution service needs to use uRLLC slice. The transmission line condition monitoring, fault alarm and intelligent meter reading need to use mMTC slice. The video monitoring of substation/transformer and robot inspection require large bandwidth eMBB slice. Figure 5.3.1-1 illustrates an example where a grid company uses three network slices simultaneously.

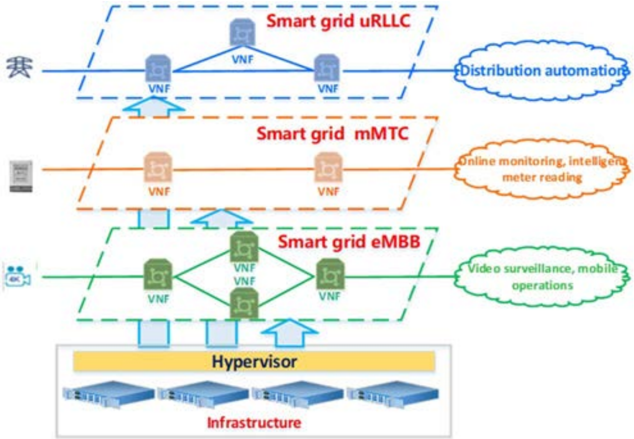

Figure 5.3.1-1: A grid company using three network slices simultaneously

Similarly, if a company deployed on a MEC system has multiple businesses with different attributes, multiple MEC App Slices will be required. It is assumed to take an example that Industrial 4.0 would be deployed on MEC. Based on the preliminary analysis of the industry, Industry 4.0 has the following key business categories, as shown in Figure 5.3.1-2.

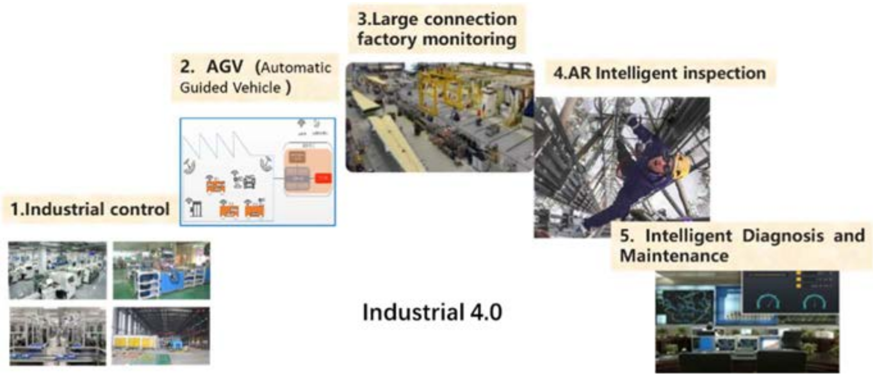

Figure 5.3.1-2: Industrial 4.0 business diagram

1. Industrial control: The workshop is equipped with sensors for relevant equipment. After the continuous monitoring data is sent to the edge control centre, the control centre makes production decisions based on the sensing data, so as to realize automatic closed-loop control.

2. AGV (Automatic Guided Vehicle): The central control system of AGV is deployed on MEC system, and wireless communication of AGV is realized by 5G network. Also virtual PLC (Programmable Logic Controller)/IPC(Industrial Personal Computer) and motion control will also be transferred to edge nodes to coordinate resources more comprehensively and effectively.

3. Large connection factory monitoring: Sensor data is sent to MEC through 5G network to complete big data analysis and machine learning, so as to obtain the optimal management rules and equipment parameters and realize intelligent production.

4. AR Intelligent inspection: In the workshop, maintenance personnel wear mobile AR glasses to upload equipment data, analyse the working status of equipment edge, and provide fault maintenance guide or present technical guidance in the form of AR.

5. Intelligent Diagnosis and Maintenance: The production line transmits the equipment data to MEC through 5G network in real time. After the intelligent diagnosis system analyses and makes decisions, the results are returned to the equipment, so as to obtain the priority configuration parameters and improve product quality.

Based on the above description, it can be concluded that the same enterprise may also need multiple MEC App slices.

5.3.2 Recommendations

- MEC system should be able to allocate the matched MEC Application Slices to different services among the single Enterprise.

5.3.3 Evaluation

Recommendations of clause 5.3.2 are technically feasible with the following condition:

- When an enterprise has multiple businesses, it can be split according to the business attributes. This splitting function is placed on OSS or higher and is out the scope of ETSI MEC. The support for the MEC system to instantiate the corresponding MEC Application Slices according to business attributes is missing.

5.4 Use case #4: MEC Application Slices and relation to 5G Network Slices

5.4.1 Description

As described in ETSI GR MEC 038 [i.3] clause 5.5, it is concluded that MEC Application Slices and network slices are different. However, from the perspective of customer-oriented, it seems that network slices and MEC Application Slices should be jointly considered, because a network slice and an application slice together make a user service slice. The difference between a network slice and a MEC Application Slice is that the prior is characterized by the need to fulfil specific communication service requirements (e.g. in terms of data rate, communication reliability and others), while the latter aims to isolate different client applications characterized by different application service requirements (e.g. in terms of security, referring to different vertical industries, etc.).

The present document takes the services of Smart Road Lamp as an example to illustrate the possible interworking of two kinds of slices.

Figure 5.4.1-1 is the service diagram of a Smart Road Lamp.

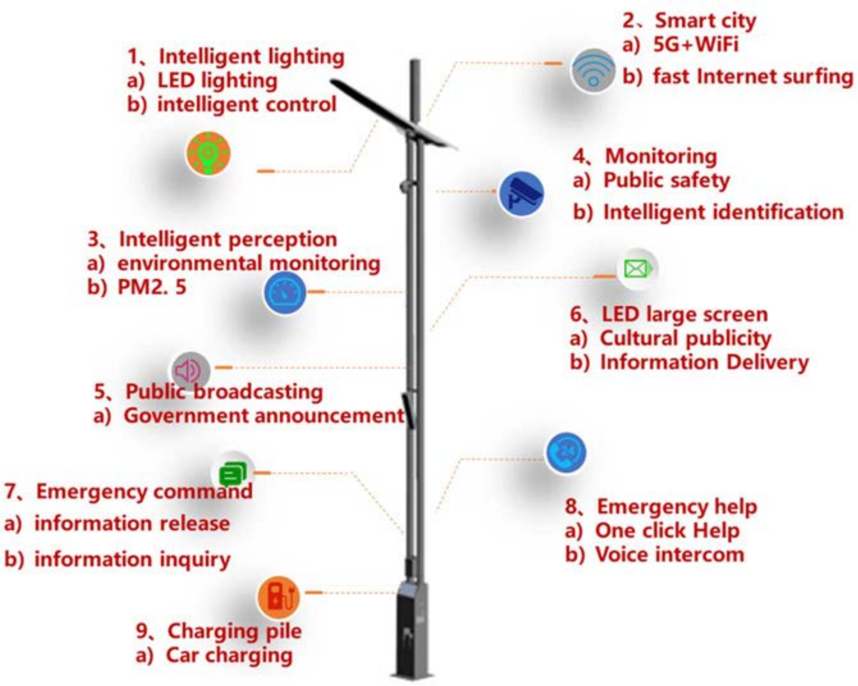

Figure 5.4.1-1: Services of Smart Road Lamp

Smart Road Lamp is a shared intensive information infrastructure. It is not only a lighting infrastructure, but also collects the information of the city through various functional sensors. It is an important source of information collection and an important entrance to the smart city.

Figure 5.4.1-1 shows 9 services of Smart Road Lamp. Except for services 1, 3 and 9 may be mMTC services without being deployed on MEC, most services are eMBB service in need of large communication bandwidths. However, their priorities are different. Some eMBB services have higher priority, for example the emergency services (service7 and service8 in the figure); and some have lower priority, for example the Internet surfing services (service2 in the figure). In descending order, it could be service7, service8, service6, service5, service4 and service2. From the perspective of services segmentation, these six types of services packaged in an eMBB network slice need to be associated with multiple MEC Application Slices. It is assumed that emergency services 7 and 8 correspond to MEC Application Slice 1, public security services 5 and 6 correspond to MEC Application Slice 2, monitoring services 4 correspond to MEC Application Slice 3, and user Internet surfing service corresponds to MEC Application Slice 4. Table 5.4.1-1 describes an exemplary mapping of network slices and MEC Application Slices.

Table 5.4.1-1: The exemplary mapping of network slice and MEC Application Slice

	Network Slice	MEC Application Slice
Service1	mMTC	-
Service2	eMBB	MECAppSlice4
Service3	mMTC	-
Service4	eMBB	MECAppSlice3
Service5	eMBB	MECAppSlice2
Service6	eMBB	MECAppSlice2
Service7	eMBB	MECAppSlice1
Service8	eMBB	MECAppSlice1
Service9	mMTC	-

So, a mechanism is needed to implement the mapping of Network Slices and MEC Application Slices according to service attributes.

5.4.2 Recommendations

[Recommendation 5.4.2-1]

- A mechanism is needed to associate one or more MEC Application Slices with one or more 5G network slices.

5.4.3 Evaluation

Recommendations of clause 5.4.2 are technically feasible with the following conditions:

- The support for application slice management functions (similar to the ones for network slicing in a 5G network) should be made available.

NOTE: A mapping table between the MEC Application Slices and 5G network slices, would be required, but this may be done on the OSS or higher level and is out the scope of ETSI MEC.

5.5 Use case #5: Life-cycle management for MEC Application Slice Instances

5.5.1 Description

MEC system is supposed to be able to provide optimized support for a variety of different communication services, different traffic loads, and different end user communities as well as 5G network slices has done. In this case, MEC Application Slices came into being.

The management of MEC Application Slices is important among its serving. As stated in ETSI TS 128 530 [i.4], clause 4.3, there are four phases of management aspects of network slicing: Preparation, Commissioning, Operation, Decommissioning. Management of MEC Application Slices will adopt similar processes and steps. As shown in Figure 5.5.1-1 Management aspects of MEC Application Slices:

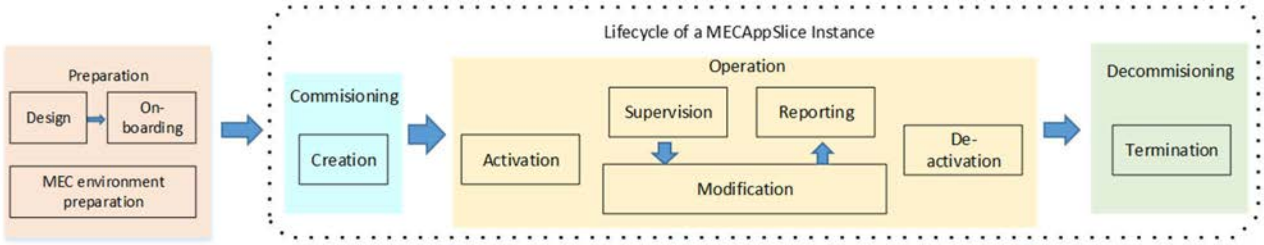

Figure 5.5.1-1: Management aspects of MEC Application Slices

Each phase is described in ETSI TS 128 530 [i.4]. The only difference is that the words: "Network Slice" and "network slice" needs to be changed to "MEC Application Slices".

In the preparation phase the MEC Application Slice instance does not exist. The preparation phase includes MEC Application Slice design, MEC Application Slice capacity planning, on-boarding and evaluation of the MEC Application Slice functions, preparing the network environment and other necessary preparations required to be done before the creation of an MEC Application Slice Instance.

MEC Application Slice Instance provisioning in the commissioning phase includes creation of the MEC Application Slice instance. During MEC Application Slice Instance creation all needed resources are allocated and configured to satisfy the MEC Application Slice requirements. The creation of a MEC Application Slice Instance can include creation and/or modification of the MEC Application Slice Instance constituents.

The Operation phase includes the activation, supervision, performance reporting (e.g. for KPI monitoring), resource capacity planning, modification, and de-activation of an MEC Application Slice instance.

Activation makes the MEC Application Slice instance ready to support communication services.

MEC Application Slice Instance provisioning in the decommissioning phase includes decommissioning of non-shared constituents if required and removing the MEC Application Slice Instance specific configuration from the shared constituents. After the decommissioning phase, the MEC Application Slice Instance is terminated and does not exist anymore.

Based on the description of the four phases, MEC Application Slice Instance is the managed object. So, a function is needed to implement the Life-cycle management for MEC Application Slice Instance.

5.5.2 Recommendations

[Recommendation 5.5.2-1]

- The MEC system should support the Life-cycle management for MEC Application Slice Instance.

5.5.3 Evaluation

Recommendations of clause 5.5.2 are technically feasible with the following condition:

- According to the definition of MEC Application Slice Instance in clause 3.1, life-cycle management for MEC Application Slice Instance is also a combination of MEC Platform LCM and MEC app LCM which has been defined and supported.

NOTE: MEC Platform LCM is not defined in the present document.

5.6 Use case #6: End-to-end QoS requirements of slice

5.6.1 Description

Various application slices provide different services that may have differentiated QoS requirements. For example, the video application slice may require high bandwidth and could endure a slight packet loss. The application slice working for industrial control may ask for ultra-low latency and have a very low tolerance for packet loss. The application slice working for XR may be different, such as ultra-low latency and super-large bandwidth that are required simultaneously.

Different slices may require different end-to-end QoS. For multi-access edge computing, both the edge network and the access network should provide guaranteed QoS.

Figure 5.6.1-1 shows an example of MEC and 5G network to implement end-to-end QoS. The 5G network can be divided into three subnets: access network, core network and transport network, which do not need to be understood by MAS-MF. MAS-MF may map the application slices into 5G network slices following some pre-configuration rules.

MAS-MF gets QoS requirements from MAS-CSMF, forwards them to the NSMF and notifies the NSMF to implement the network slices. In that case, the customer could trigger to deploy an application slice instance and a network slice instance simultaneously by purchasing only once.

NOTE 1: The MEC and 5G network may or may not be managed by the same operator. If multiple operators are related to end-to-end QoS, there should be a pre-agreed QoS mapping relationship between them.

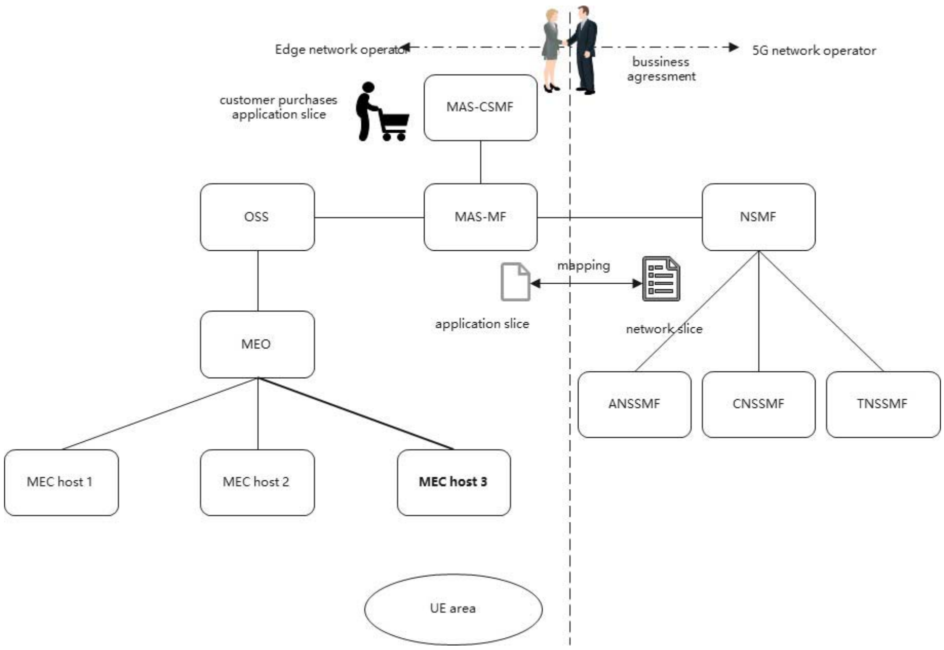

Figure 5.6.1-1: Example diagram of End-to-end QoS of slice

The enterprise customers could provide the area information of the related UEs (e.g. of the employees) to assist the system to select a suitable MEC host to create the application slice instance. For edge computing, the OSS/MEO normally are deployed at the centre of the network and manage multiple MEC hosts, which are distributed over a large area. Several MEC hosts may be available for the target application slice instance at the same time. The OSS/MEO may need to select a closer MEC host to the UEs to match the QoS requirements of the application slice.

NOTE 2: Any collected information related to individual users should be subject to regulatory requirements and user consent.

5.6.2 Recommendations

[Recommendation 5.6.2-1]

- MEC system should support the selection of MEC hosts according to the input conditions coming from application slice customers.

[Recommendation 5.6.2-2]

- MEC system should coordinate with the related access networks, via an open interface, in order to satisfy the end-to-end QoS requirements.

5.6.3 Evaluation

[Evaluation for Recommendation 5.6.2-1]

- In ETSI GS MEC 010-2 [i.6], some attributes defined in InstantiateAppRequest have been able to indicate or constrain the selectable MEC hosts. The current MEC system has supported the MEC host selection.

[Evaluation for Recommendation 5.6.2-2]

- The end-to-end QoS requirements depend on both edge network and access network. How to collaborate with other network is out of the scope of ETSI MEC.

5.7 Use case #7: Different application slices including differentiated instances of the same application

5.7.1 Description

The resource requirements of different applications are different. All the resource requirements of an application are described in AppD. During the application instantiation, the MEC system should allocate resources according to AppD. One application can be instantiated several times to generate multiple application instances. These instances have their own IP address, but generally they have to work with load-balance function and expose only one IP address as service IP.

Different users may have different requirements when accessing one application. The operator could design application slices to satisfy users.

AI computing power slice

The operator could sell amateur AI slice for personal learning or entertainment, which only need lightweight AI computing power. Meanwhile, the professional AI slice is provided by the operator to support massive computing tasks that need heavyweight AI computing power.

Image processing slice

An application that provides a rendering service could be used for simple image processing, and can also be used for large-scale 3D game scenarios that require a dedicated GPU. The operator could provide different rendering capabilities through different image processing slices.

High-security slice

High-security slice is used to provide isolation accessing and/or independent infrastructures to users who have very high-security requirement. The users seeking high security may want dedicated APP instances. The isolation of data access can avoid the potential impacts brought by other broken application instances. Users may even require instantiation on different infrastructures, such as independent servers, to isolate physical resources from other services.

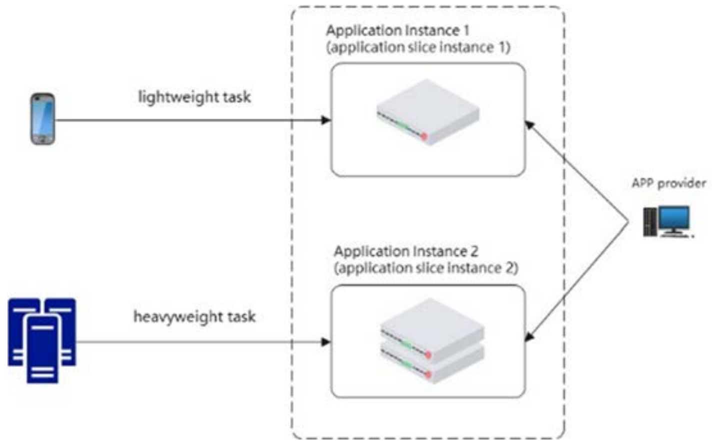

Figure 5.7.1-1: Different users access different application instances

5.7.2 Recommendations

[Recommendation 5.7.2-1]

- MEC system should support differentiated application instances of the same application.

5.7.3 Evaluation

[Evaluation for Recommendation 5.7.2-1]

- How to create different application instances of the same application depends on implementation and will be discussed in the solution part.

6 Solutions for closing the gaps

6.1 Gap/Key issue #1 - Management entities for MAS

6.1.1 Description

Typical MEC Application Slices (MAS) scenarios are considered, as described in use cases #1, #2, #3 and #4, MEC Application Slices and their relation to 5G Network Slices indicate that the MEC system should support application slice management functions similar to the ones for network slicing in a 5G network.

Under the current MEC architecture, no role and entity manage the system information and lifecycle of MAS. However, in the case where MAS services are required, it is needed to consider appropriate entities to fulfil these roles, i.e. a MAS Communication Service Management Function and a MAS Management Function.

It is supposed that the MAS Communication Service Management Function and the MAS Management Function deal with all the requirements from the contracts with end customers and can subdivide these requirements to realize the life cycle management of MEC slices and the final operation of the MEC Application Slice services.

6.1.2 Solution proposal #1-1: MAS Communication Service Management Function

The MAS Communication Service Management Function(MAS-CSMF) is similar to CSMF (Communication Service Management Function) in 5G network slice as described in clause 4.10 of 3GPP TR 28.801 [i.5].

The MAS Communication Service Management Function (MAS-CSMF) is located in the MAS management area and connected to MAS Slices Management Function (MAS-MF) as depicted in Figure 6.1.2-1.

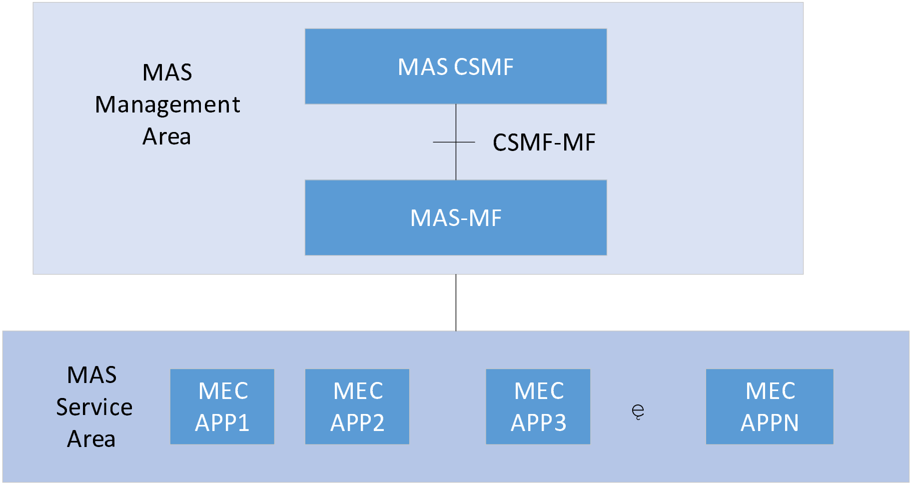

Figure 6.1.2-1: MEC Application Slices management entities

MAS CSMF is mainly responsible for customer-oriented management services of the MECApplication Slices with the following functionalities:

- Translating the communication service-related requirement into slice-related requirements.
- MEC Application Slice purchase.
- Exposure of MAS' Creation, Updating, and Deletion (through invoking the API: Life-cycle management for MEC Application Slice Instance).
- Exposure of service performance and alarm information, enabling SLA monitoring services for customers.

6.1.3 Solution proposal #1-2: MAS Management Function

The MAS Management Function (MAS-MF) is similar to the combination of NSMF (Network Slice Management Function) and NSSMF (Network Slice Subnet Management Function) in 5G network slice as described in clause 4.10 of ETSI TS 128 530 [i.4].

The MAS Management Function (MAS-MF) is located in the MECAppSlices management area and interacts with MAS Communication Service Management Function (MAS-CSMF) as depicted in Figure 6.1.2-1.

MAS Management Function (MAS-MF) is mainly responsible for the management and orchestration of MSI (MEC Application Slice instance) with the following functionalities:

- MEC Application Slice Template design.
- MEC Application Slice lifecycle management.

6.2 Gap/Key issue #2 - Relationship between newly introduced entities and MEC system

6.2.1 Description

Typical MEC Application Slices scenarios are considered, as described in clause 5. Clause 6.1 describes the newly introduced entities and their functions. This KI is to clarify their relations with MEC system, such as:

- the location of them in the MEC system;
- which needs to be standardized in MEC system.

6.2.2 Solution proposal #2-1: Possible combinations of newly introduced entities and MEC system

As stated in clauses 6.1.2 and 6.1.3, the MEC Application Slices Communication Service Management Function (MAS-CSMF) is responsible for customer-oriented management services of the MEC Application Slices, and the MEC Application Slices Management Function (MAS-MF) mainly responsible for the management and orchestration of MASI (MEC Application Slice Instance).

According to ETSI GS MEC 003 [i.7] and the above analysis, MEC Application Slice Communication Service Management Function (MAS-CSMF) is a service layer function outside of MEC system (inside or outside the OSS). Its standardization is outside of MEC system.

MEC Application Slice Management Function (MAS-MF) is a core entity of MEC Application Slice lifecycle management and is recommended to be standardized in MEC system. And it may be inside or outside the MEO.

The possible combinations of newly introduced entities and MEC system is shown in Figure 6.2.2-1.

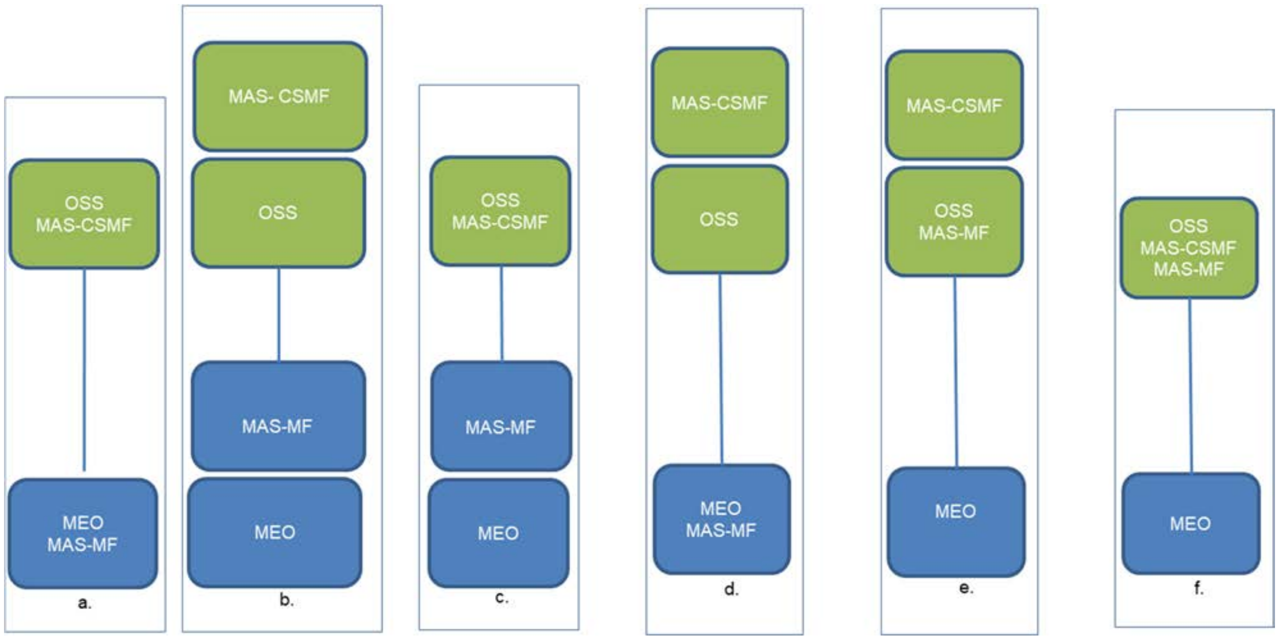

Figure 6.2.2-1: Possible combinations of newly introduced entities and MEC system

6.3 Gap/Key issue #3 - Analysis for combinations of newly introduced entities and MEC system

6.3.1 Description

Clause 6.2 describes six combinations of the newly introduced entities and MEC system. This KI is to analyse their advantages and disadvantages, such as:

- whether a new interface is introduced;
- impact on existing MEC network elements.

6.3.2 Solution proposal #3-1: Comparative analysis of different combinations

As stated in clause 6.2.2, Figure 6.2.2-1, possible combinations of newly introduced entities and MEC system shows six combinations, namely a, b, c, d, e and f. The six combinations will be further analysed from the perspective of interfaces.

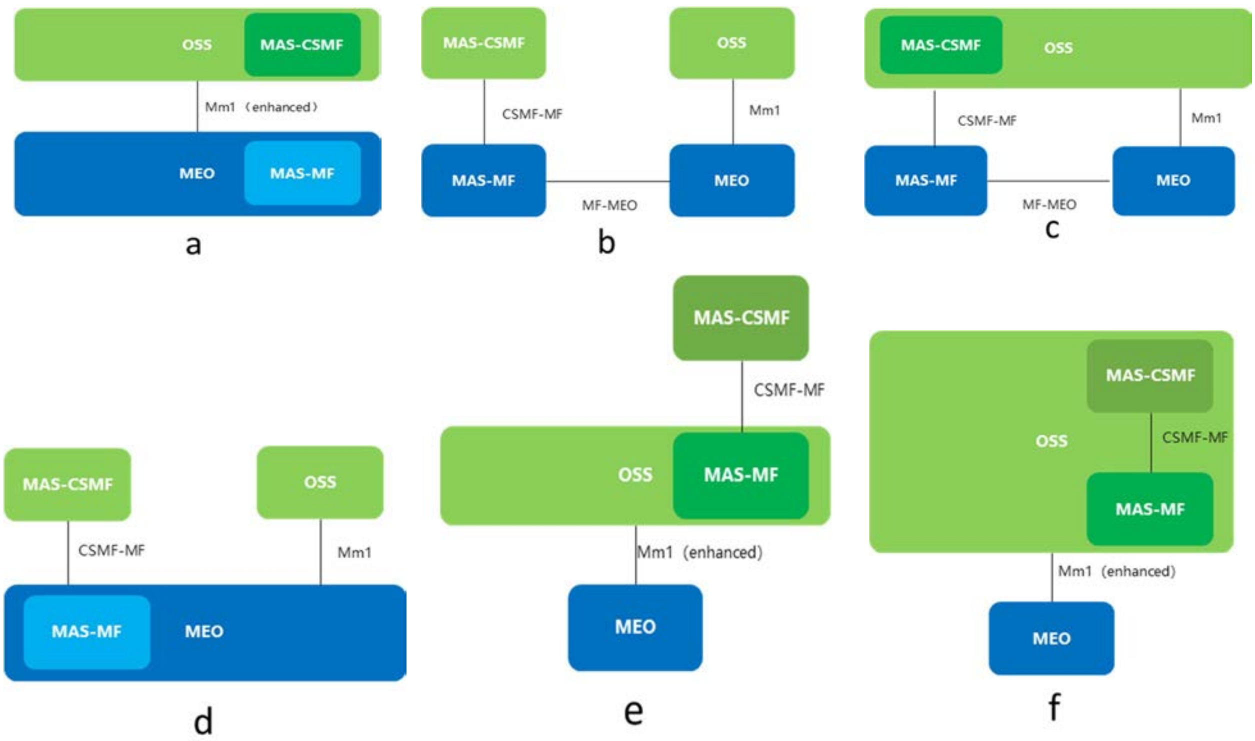

Figure 6.3.2-1: Detailed analysis of each combination based on interface

Combination a: MAS-CSMF and OSS are combined, MAS-MF and MEO are combined, and there is no new interface, only Mm1 needs to be enhanced.

Combination b: Introduce 2 independent entities which are MAS-CSMF and MAS-MF, and introduce two new interfaces which are CSMF-MF and MF-MEO.

Combination c: MAS-CSMF and OSS are combined. One individual entity: MAS-MF. And two new interfaces: CSMF and MF-MEO.

Combination d: MAS-MF and MEO are combined. One individual entity: MAS-CSMF (which is not the real entity for that will not be standardized in MEC).And one new interface: CSMF-MF.

Combination e: MAS-CSMF and OSS are combined. One individual entity: MAS-CSMF (which is not the real entity for that will not be standardized in MEC).And one new interface: CSMF-MF (which is not the real interface for its outside of the MEC system); And Mm1 interface need to be enhanced.

Combination f: MAS-CSMF, MAS-MF and OSS are combined.Mm1 interface need to be enhanced.

Table 6.3.2-1 reflects the above comparison.

Table 6.3.2-1: Comparison of different combinations

	Newly introduced entity(need to be standardized)	Newly introduced interface	The interface to be enhanced	Whether MAS-MF is built into the MEO
Combination a	0	0	Mm1	yes
Combination b	1	2	-	No
Combination c	1	2	-	No
Combination d	0	1	-	yes
Combination e	0	0	Mm1	No
Combination f	0	0	Mm1	No

From the direct comparison of Table 6.3.2-1, it can be inferred that the combination of a, e and f does not need to add new entities and interfaces, but only needs to enhance Mm1, but a little difference is that MAS-MF needs to be built into MEO for combination a. For combination b and c, one entity and two interfaces need to be added and Mm1 remains unchanged. Combination d only introduces a new interface: CSMF-MF and MAS-MF needs to be built into MEO.

Therefore, from the perspective of interface complexity, combination b and c can be excluded. Combination e and f seem to have the same complexity, whether MAS-CSMF is inside OSS or outside OSS, but in fact they are both outside MEC system, so only one can be chosen, the more simplified combination f is recommended. Combination d does not seem to be complicated. It only adds an interface, but it seems to have changed the existing architecture greatly.

Based on the above analysis, combinations a and f are recommended as benchmarks for the relationship between the newly introduced entity and the MEC system.

6.4 Gap/Key issue #4 - Slice template management process

6.4.1 Description

Clause 6.3 recommends combinations a and f as the benchmark architectures for MEC App Slice (MAS) and points out they are different regards the `Mm1` enhanced information. The following chapters will introduce the slice template management process for architecture a from six aspects: On-board, Disable, Enable, Query, Update and Delete, while also describe the differences in these processes between the two architectures.

MAS Template (MAST) is a collection of parameters used to define an information model, such as the MAST Id, name, designer, version, releaseTime, description and other parameters of this MAS.

6.4.2 Solution proposal #4-1: On-board MEC Application Slice Template

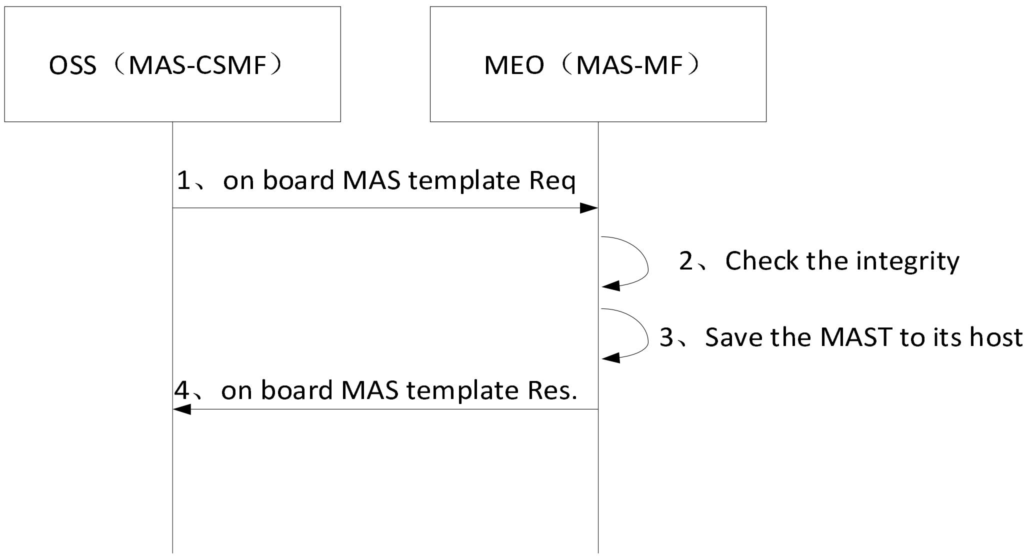

Figure 6.4.2-1: On-board MEC Application Slice Template

1. The MAS-CSMF sends an on-board MAS template request to the MAS-MF.
2. The MAS-MF verifies the integrity of the MAS template, including mandatory parameters in the MAS template. If the verification is not passed then, "failure" is return back.
3. The MAS-MF saves MAS template to its host.
4. The MAS-MF returns "success" to the MAS-CSMF.

NOTE: For architecture f: The MAS-CSMF and the MAS-MF are combined together, there is no such "On-board" process step 1 and step4.

6.4.3 Solution proposal #4-2: Disable MEC Application Slice Template

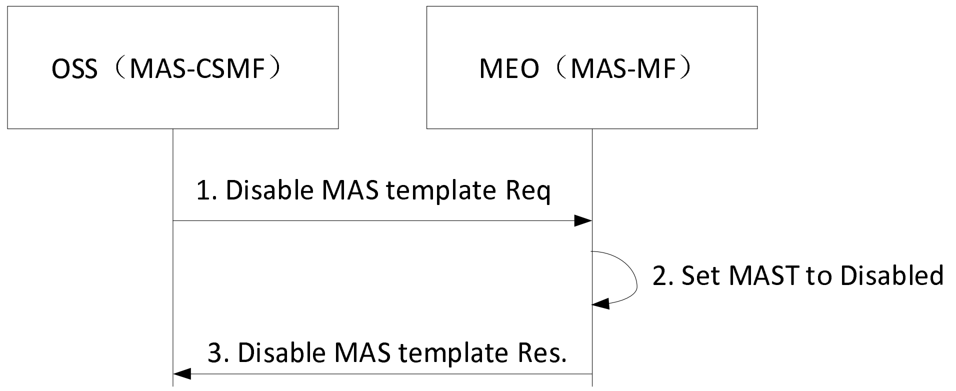

Figure 6.4.3-1: Disable MEC Application Slice Template

1. The MAS-CSMF sends a request to disable MAS template to the MAS-MF. The disabled MAS template cannot be used to instantiate new application slice instances, but it does not affect already instantiated application slice instances.
2. The MAS-MF sets the MAS template status to "Disabled".
3. The MAS-CSMF gets the disable slice template response.

NOTE: For architecture f: The MAS-CSMF and the MAS-MF are combined together, there is no such "disable" process for step 1and step3.

6.4.4 Solution proposal #4-3: Enable MEC Application Slice Template

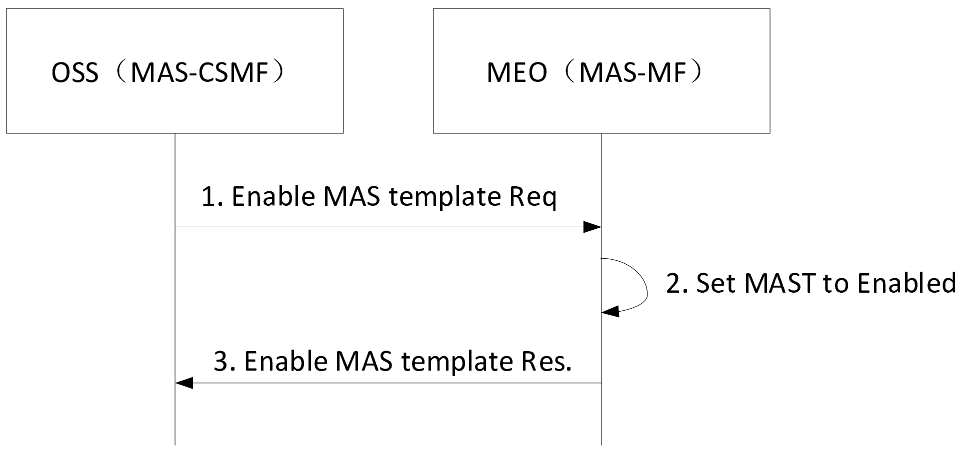

Figure 6.4.4-1: Enable MEC Application Slice template

1. The MAS-CSMF sends a request to enable MAS template to the MAS-MF. The enabled MAS template can be used to instantiate new application slice instances.
2. The MAS-MF sets the MAS template status to "Enabled".
3. The MAS-CSMF gets the enable slice template response.

NOTE: For architecture f: The MAS-CSMF and the MAS-MF are combined together, there is no such "enable" process for step 1and step3.

6.4.5 Solution proposal #4-4: Query MEC Application Slice Template

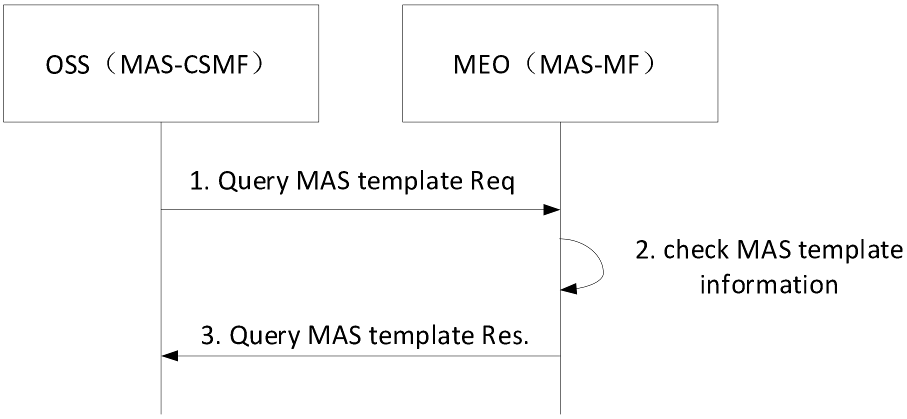

Figure 6.4.5-1: Query MEC Application Slice Template

1. The MAS-CSMF sends a query MAS template information request (including a filter, such as template ID or version) to the MAS-MF to query information of MAS templates.
2. The MAS-MF queries its own database to obtain the MAS template information, including the basic MAS template information. In addition, it can query the brief information about the instantiated MEC Application Slice Instance related to the MAS template.
3. The MAS-MF returns the query result to the MAS-CSMF.

NOTE: For architecture f: The MAS-CSMF and the MAS-MF are combined together, there is no such "query" process for step1 and step3.

6.4.6 Solution proposal #4-6: Update MEC Application Slice Template

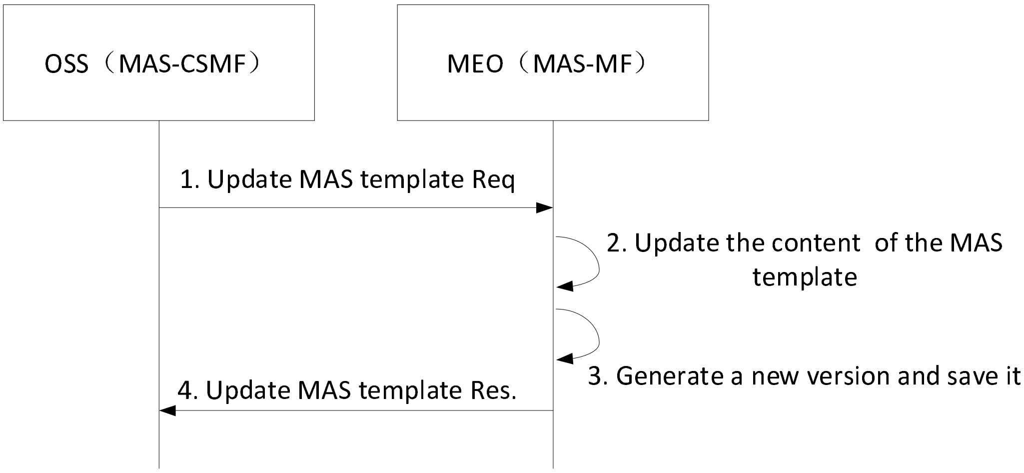

Figure 6.4.6-1: Update MEC Application Slice Template

1. The MAS-CSMF sends a request to update MAS template information to the MSA-MF.
2. The MAS-MF updates the MAS template based on the updated content. The content of the update includes the modification of the resource model, management model and capability model of the MAS template.
3. The MAS-MF generates a new version number for the updated template.
4. The MAS-MF returns the update result to the MAS-CSMF.

NOTE: For architecture f: The MAS-CSMF and the MAS-MF are combined together, there is no such "update" process for step1 and step 4.

6.4.7 Solution proposal #4-7: Delete MEC Application Slice Template

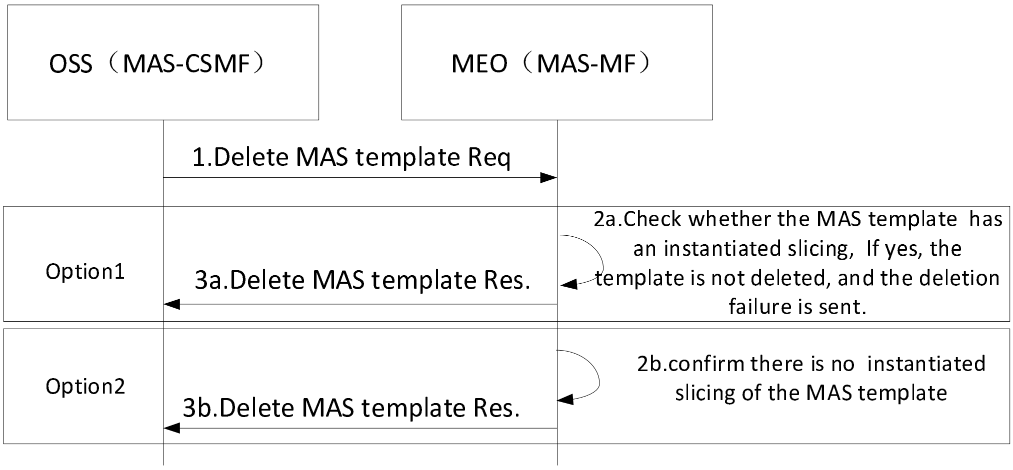

Figure 6.4.7-1: Delate MEC Application Slice Template

1. The MAS-CSMF sends a request to delete MAS template to the MAS-MF.

2a. The MAS-MF checks whether the MAS template has an instantiated slicing. If yes, the template is not deleted, and the deletion failure is sent.

3a. The MAS-MF returns "delete failure" to the MAS-CSMF.

2b. The MAS-MF checks whether the MAS template has an instantiated slicing and confirm there is no instantiated slicing of the MAS template.

3b. The MAS-MF returns "delete success" to the MAS-CSMF.

NOTE: For architecture f: The MAS-CSMF and the MAS-MF are combined together, there is no such "delete" process for step 1 and step3.

6.5 Gap/Key issue #5 - MAS Lifecycle Management Process for Architecture a/f

6.5.1 Description

As stated in clause 5.5, MAS Lifecycle Management Process includes creation, activation, update, deactivation and termination. But there is a special case outside of these processes: sharing the existing MAS instance. The following clauses provide a detailed description of all these processes and provide the differences between the two architectures: a and f in these functions.

6.5.2 Solution proposal #5-1: Sharing the existing MAS instance

In Figure 6.5.2-1 is the process and description of sharing the existing MAS instance.

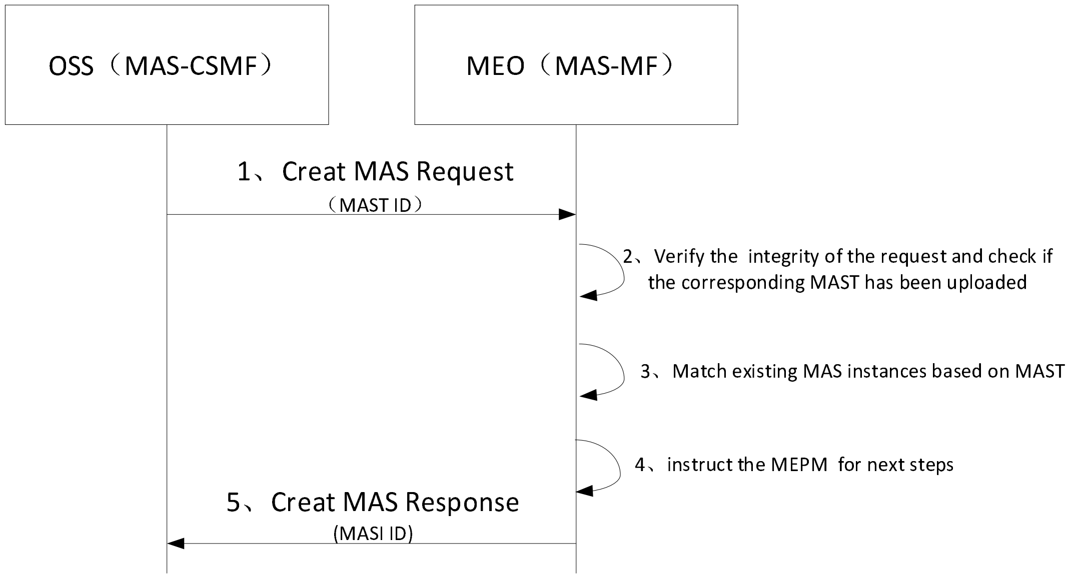

Figure 6.5.2-1: Sharing the existing MAS instance

1. The MAS-CSMF sends a request to share a MAS instance to the MAS-MF with the specific information, such as the MEC Application Slice Template identifier MAST ID.
2. After receiving the request, the MAS-MF verifies its integrity, and checks if the corresponding MAST template has been loaded into the MAS-MF. If the corresponding MAST is not loaded, a failure is returned.
3. Based on the MAST template and sharing request, MAS-MF searches and matches existing slice instances that meet the requirements.
4. If the MASI found can be shared, then the MAS-MF instructs the MEPM to create the sharing MASI, including the MAS-MF issues relevant configurations through the NFMF to which MEC-APP/NF belongs. Otherwise, the process of creating a new MAS instance will be followed.
5. The MAS-MF returns the sharing result, and a new MASI ID is returned after successful sharing.

NOTE: For architecture f: The MAS-CSMF and the MAS-MF are combined together, there is no such "sharing" process for step 1 and step5.

6.5.3 Solution proposal #5-2: MAS instance creation process

In Figure 6.5.3-1 is the process and description of MAS instance creation.

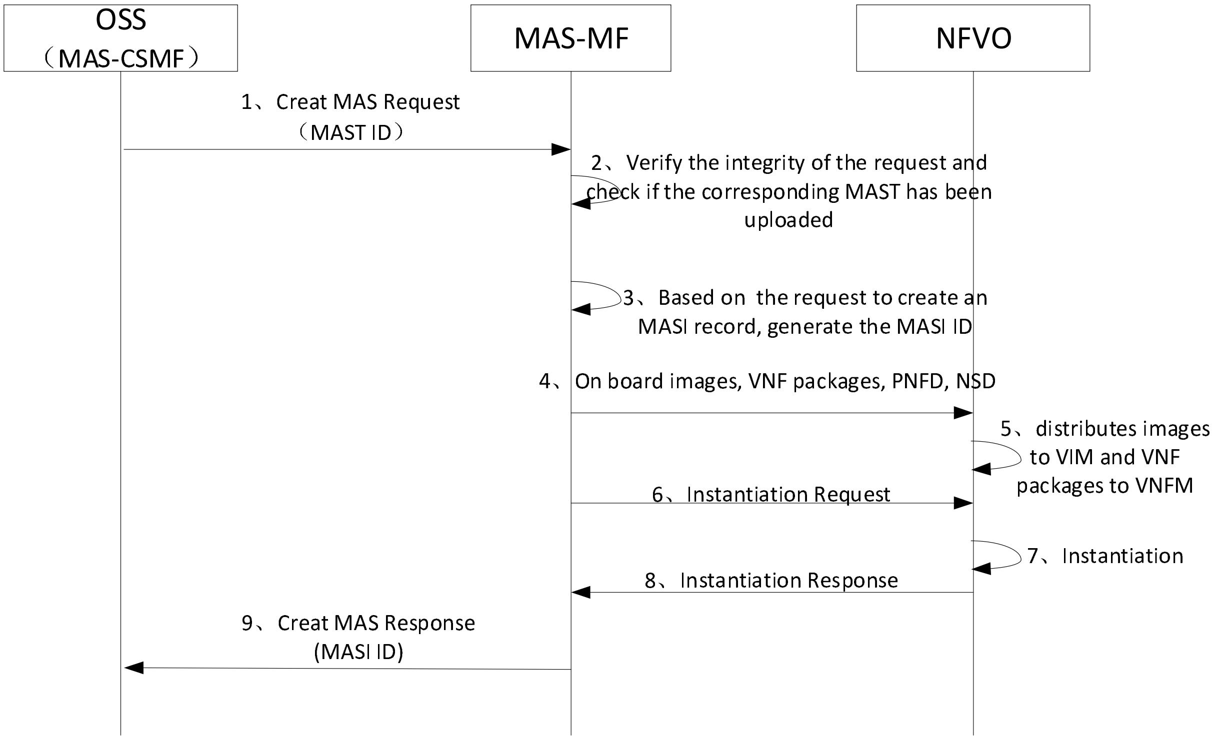

Figure 6.5.3-1: Creating a MAS process

1. The MAS-CSMF sends a request to create a MAS to the MAS-MF with the specific information, such as the MEC Application Slice Template identifier MAST ID.
2. After receiving the request, the MAS-MF verifies its integrity, and checks if the corresponding MAS template has been loaded into the MAS-MF. If the corresponding MAST is not loaded, a failure is returned.
3. Based on the creation request, the MAS-MF creates an MASI and generates the MASI ID.
4. The MAS-MF uploads NSD and VNF images, VNF packets involved in NSD to NFVO through the NFVO interface (if NSD, VNF packets have already been uploaded to NFVO during the preparation phase or previous slice creation, this step can be omitted).
5. The NFVO distributes images to VIM and VNF packages to VNFM. (If the image and VNF package have been distributed to VIM and VNFM, this step can be omitted).
6. The MAS-MF sends an instantiation request to NFVO with the instantiated inputs parameters required to instantiate the MAS instance.
7. The NFVO executes the slice instantiation process including the configuration (MEPM, MEP, MEC APPs and VIM involved).
8. The NFVO returns instantiation result response to the MAS-MF with the MASI ID.
9. The MAS-MF returns the creation result to the OSS with the MASI ID.

NOTE 1: For architecture a: The MAS-CSMF is embedded in the OSS, and the MAS-MF is embedded in the MEO, there is no step 4, step 6 and step 8 process between the MAS-MF and the NFVO.

NOTE 2: For architecture f: The MAS-CSMF and MAS-MF are combined together, so there is no step 1 and step 9.

NOTE 3: This creation process of a MAS refers to Figure 5.7.2-1: Instantiate application in NFV through MEAO of ETSI GS MEC 010-2 [i.6].

6.5.4 Solution proposal #5-3: Operate MAS Instance process

According to the description of clause 5.5.1, operation includes activation, modification and deactivation.

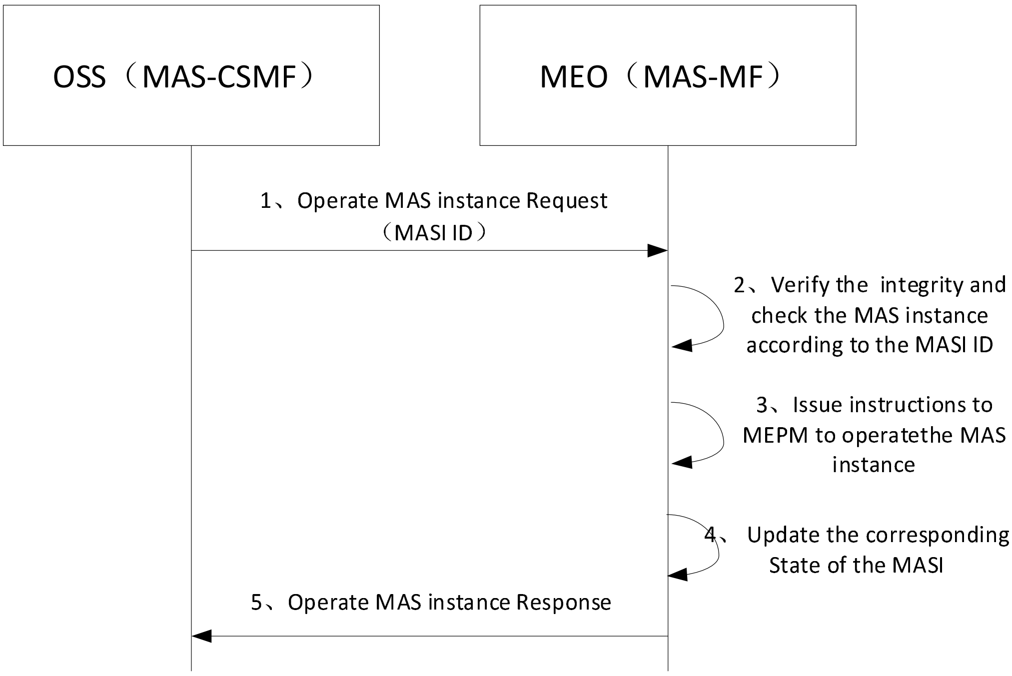

Figure 6.5.4-1: Operation of a MASI

1. The MAS-CSMF sends a request to operate a MAS instance to the MAS-MF with the MEC Application Slice Instance identifier MASI ID.
2. After receiving the request, the MAS-MF verifies its integrity, and checks the validity of the parameters carried in the request.
3. The MAS-MF issues instruction to MEPM to operate (activate, modify or deactivate) the MAS instance.
4. When operation finished, the MAS-MF updates the "state" of the MASI according to the corresponding operation.
5. The MAS-MF returns the operation result of the MASI ID.

NOTE: For architecture f: The MAS-CSMF and the MAS-MF are combined together, there is no such "operation" process step 1 and step 5.

6.5.5 Solution proposal #5-4: Terminate MAS Instance process

According to the description of clause 5.5.1, the final process of MAS lifecycle management process is termination.

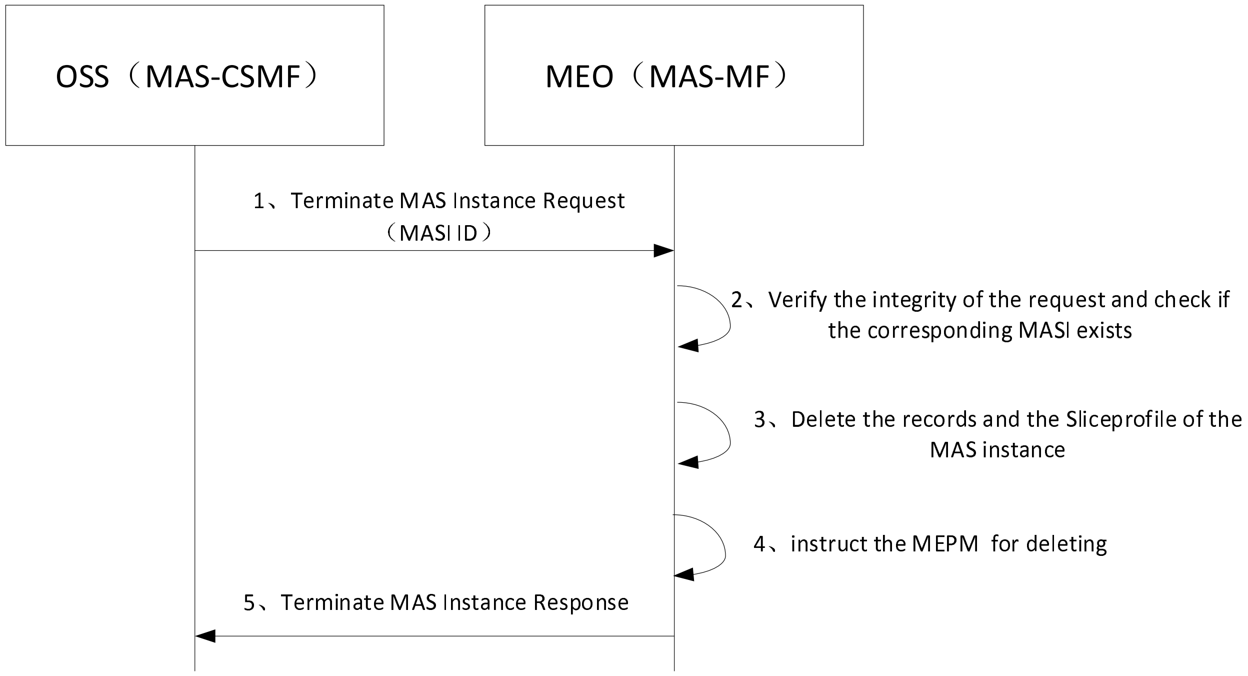

Figure 6.5.5-1: Terminate a MASI

1. The MAS-CSMF sends a terminate MAS instance request to the MAS-MF to delete the MAS instance with the MASI ID.

2. After receiving the request, the MAS-MF verifies its integrity, and check if the MAS instance exists according to the MASI ID.

3. The MAS-MF deletes the records and the Sliceprofile of the MAS instance.

4. The MAS-MF issues instruction to MEPM to delete the MAS instance for the next steps.

5. When deletion finished, the MAS-MF returns the termination result of the corresponding MASI ID.

NOTE: For architecture f: The MAS-CSMF and the MAS-MF are combined together, there is no such "termination" process step 1 and step 5.

6.6 Gap/Key issue # - Mapping of QoS requirements between MEC Application Slices and Network Slices

6.6.1 Description

Network slices and MEC Application Slices should be jointly considered, as described in use case #4. Besides, different MEC Application Slices may require different end-to-end QoS, as described in use case #6. In turn, each network slice supports a set of services with specific QoS requirements. Therefore, a key issue for jointly considering MEC Application Slices and network slices is to map the QoS requirements between both.

6.6.2 Solution proposal #1-1: QoS mapping based on 5QI

In the case of the 5G network, the QoS requirements of a service in a network slice are defined through the 5G QoS Indicator (5QI) described in ETSI TS 123 501 [i.8]. The 5QI is a scalar that is used as a reference to the following 5G QoS characteristics:

i) the resource type, which can be Guaranteed Bit Rate (GBR), Delay-Critical GBR or non-GBR;

ii) the Priority Level (PL) value;

iii) the Packet Delay Budget (PDB);

iv) the Packet Error Rate (PER);

v) the Averaging window (for GBR and Delay-Critical GBR resource type); and

vi) the Maximum Data Burst Volume (MDBV) (for Delay-critical GBR resource type).

For GBR resource type, the QoS requirements include two additional QoS parameters, namely the Guaranteed Flow Bit Rate (GFBR) and the Maximum Flow Bit Rate (MFBR), which are defined for UpLink (UL) and DownLink (DL) communication.

A MEC Application Slice may be composed of different services with different QoS requirements. As described in clause 5.6, the MAS-MF gets these requirements from the MAS-CSMF and notifies the NSMF to implement the network slices. For this purpose, the MAS-MF should map the QoS requirements of the services of the MEC Application Slice into one or more 5QIs whose 5G QoS characteristics fit with these QoS requirements. If the mapping is done to a 5QI of GBR resource type, the values of GFBR and MFBR should also be set.

Table 6.6.2-1 shows an exemplary mapping between the QoS requirements of the services of two MEC Application Slices and the 5QI values of the network slices. The example shows the MEC Application Slice MAS_1 with three services denoted as Service_1, Service_2 and Service_3, each one with different QoS requirements, denoted as QoS_1, QoS_2 and QoS_3, respectively. The three services are provided with the same Network_Slice_1 and three different 5QI values, denoted as 5QI_a, 5QI_b and 5QI_c. The example also shows the MEC Application Slice MAS_2 with two services, Service_1 and Service_4, where Service_1 has in this case QoS_1'. In this case each service is supported by a different network slice and 5QI value. In the example, the QoS requirements of both Service_2 and Service_4 are mapped to the same 5QI_b. The specific criteria to carry out the mapping are implementation dependent.

Table 6.6.2-1: Exemplary mapping between QoS requirements of MEC Application Slices and 5QI values

Service and QoS requirement	MEC Application Slice	Network slice	5QI
Service_1 (QoS_1)	MAS_1	Network_slice_1	5QI_a
Service_2 (QoS_2)	MAS_1	Network_slice_1	5QI_b
Service_3 (QoS_3)	MAS_1	Network_slice_1	5QI_c
Service_1 (QoS_1')	MAS_2	Network_slice_2	5QI_d
Service_4 (QoS_4)	MAS_2	Network_slice_3	5QI_b

7 Conclusion

The mapping of the key issues, identified in clause 6, to their associated solutions is provided in Table 7-1. This includes highlighting any identified gaps and external dependencies.

Table 7-1: Key issue and solution evaluation

Key issues	Clause #	Solution	Gap	External dependency
#1: Management entities for MECAppSlices	6.1	#1: MECAppSlices Communication Service Management Function	No	No
		#2: MECAppSlices Slice Management Function	No	No
#2: Relationship between newly introduced entities and MEC system	6.2	#1: Possible combinations of newly introduced entities and MEC system	No	No
#3: Analysis for combinations of newly introduced entities and MEC system	6.3	#1: Comparative analysis of different combinations Recommended combinations are "a" and "f"."	Yes, ETSI GS MEC 003 [i.7]	No
#4: Slice Template Management Process for Architecture a	6.4	#1: On-board MEC Application Slice Template	Yes, ETSI GS MEC 010-2 [i.6]	No
		#2: Disable MEC Application Slice Template	Yes, ETSI GS MEC 010-2 [i.6]	No
		#3: Enable MEC Application Slice Template	Yes, ETSI GS MEC 010-2 [i.6]	No
		#4: Query MEC Application Slice Template	Yes, ETSI GS MEC 010-2 [i.6]	No
		#5: Update MEC Application Slice Template	Yes, ETSI GS MEC 010-2 [i.6]	No
		#:6: Delete MEC Application Slice Template	Yes, ETSI GS MEC 010-2 [i.6]	No
#5: MAS Lifecycle Management Process for Architecture a/f	6.5	#1: Sharing the existing MAS instance	Yes, ETSI GS MEC 010-2 [i.6]	No
		#2: MAS instance creation process	Yes, ETSI GS MEC 010-2 [i.6]	No
		#3: Operate MAS Instance process	Yes, ETSI GS MEC 010-2 [i.6]	No
		#4: Terminate MAS Instance process	Yes, ETSI GS MEC 010-2 [i.6]	No
#6: Mapping of QoS requirements between MEC Application Slices and Network Slices	6.6	#1: QoS mapping based on 5QI	No	Yes, ETSI TS 128 530 [i.4]

ETSI ISG MEC may take the above recommendations into further consideration.

Annex A:
Change History

Version	Date	Information about changes
	March 2022	TB adoption of WI, see contribution MEC(22)000130r1 in MEC#29.
V3.0.1	March 2022	Implements document MEC(22)000148r3 and MEC(22)000159r1.
V3.0.2	April 2022	Implements document MEC(22)000160r1 and MEC(22)000161r2.
V3.0.3	May 2022	Implements document MEC(22)000180r1,MEC(22)000181r2, MEC(22)000189r2.
V3.0.4	June 2022	Implements document MEC(22)000261r1, MEC(22)000262r1, MEC(22)000263r1 and MEC(22)000264r1.
V3.0.5	August 2022	Implements document MEC(22)000351r1, MEC(22)000352r1.
V3.0.6	October 2022	Implements document MEC(22)000353r2.
V3.0.7	January 2023	Implements document MEC(23)000007r3.
V3.0.8	February 2023	Implements document MEC(23)000045r1 and MEC(23)000046r1.
V3.0.9	June 2023	Implements document MEC(23)000112 and MEC(23)000183r1.
V3.0.10	July 2023	Implements document MEC(23)000, MEC(23)000182r1.
V3.0.11	December 2023	Implements documents MEC(23)000527r1, MEC(23)000528r2, MEC(23)000529r2, MEC(23)000530r2, MEC(23)000531r1 and MEC(23)000532.
V3.0.12	December 2023	Implements document MEC(23)000536r3.
V3.0.13	January 2024	Implements document MEC(24)000005r1, MEC(24)000006r1 and MEC(24)000009r1.
V3.0.14	January 2024	Implements document MEC(24)000016r1 and MEC(24)000041r1.
V3.0.15	February 2024	Stable draft after ***editHelp!*** Clean-up
V3.0.16	February 2024	Final draft V3.0.16 is similar to Stable draft V3.0.15 and is ready to be sent to Remote Consensus for ISG MEC review.
V3.0.17	March 2024	Final draft V3.0.17 takes into account the comments made during the MEC RC for review and is ready to go to MEC RC for approval.
V3.1.1	April 2024	First published version

History

Document history		
V3.1.1	April 2024	Publication